Paper 116: Scalable ROS-Based Architecture to Merge Multi-source Lane Detection Algorithms

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Presentation Structure

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    b. Combination of multiple algorithms from a single camera
    c. Combination of several cameras, each with one or two algorithms
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1. Introduction

ATLASCAR Project

ATLASCAR1
(Ford Escort 1998)

ATLASCAR2
(Mitsubishi i-MiEV 2015)

1. Introduction

- Data from the LIDAR (Light Detection And Ranging) is not sufficient for the perception of road boundaries;
- Detection of road lines/boundary is one of the most important domains of autonomous driving;
- There are several algorithms for detection of limits/road lines, however, there is not one that individually satisfies all situations.

2. Proposed Approach

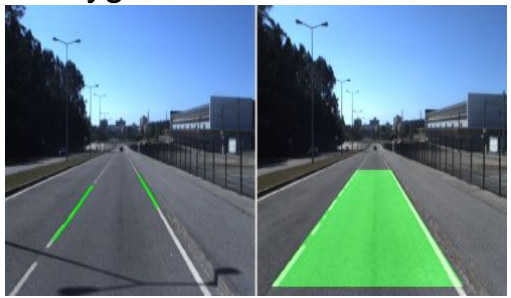
a. Parametrization of detection algorithms

Multiple types of road lane detectors

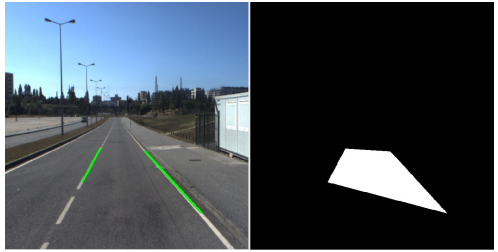
Input: image from a single camera or multiple cameras

Output:

Polygon of the road lane



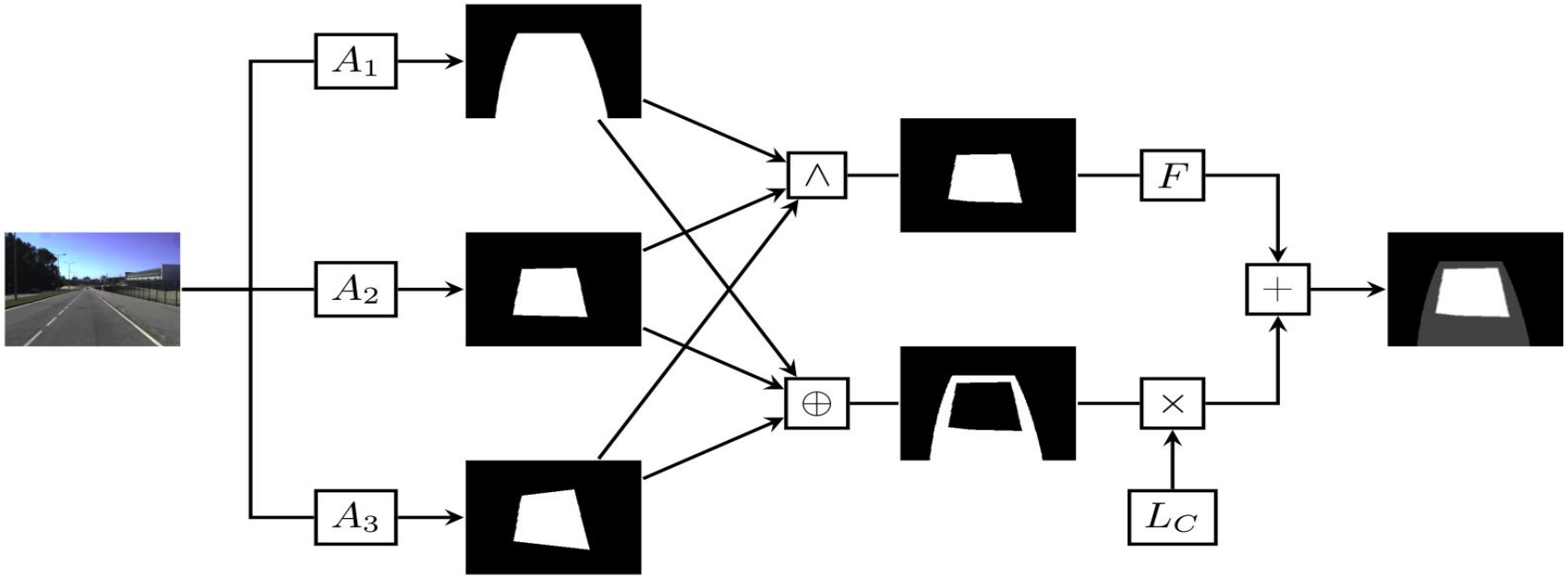
Lines delimiting the lane



All algorithms' outputs have to be on the same data type

2. Proposed Approach

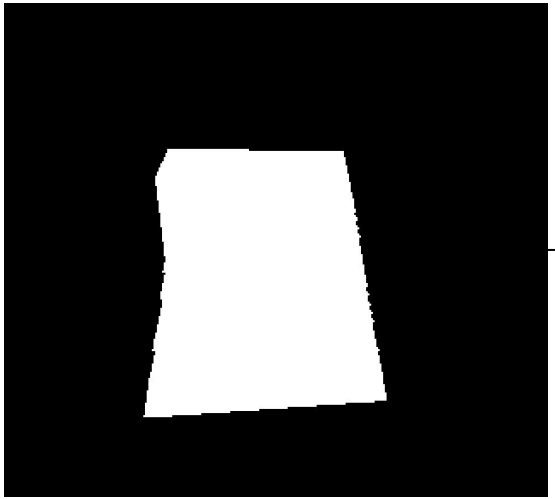
b. Combination of multiple algorithms from a single camera



2. Proposed Approach

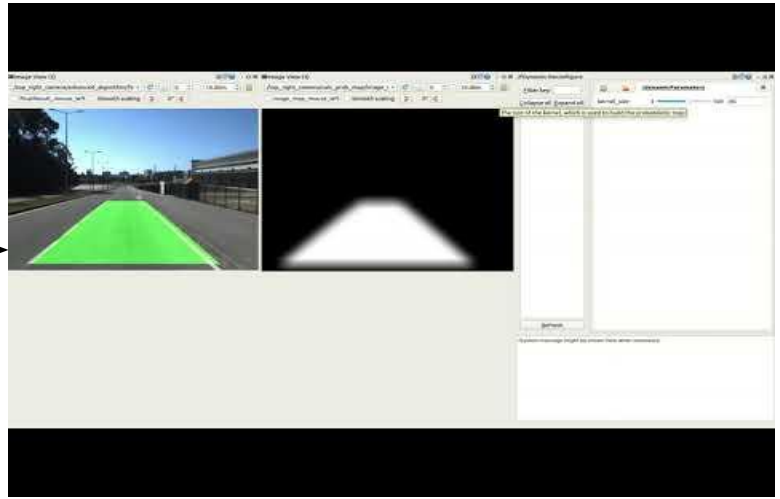
1. Blur Filtering

I



$$F = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

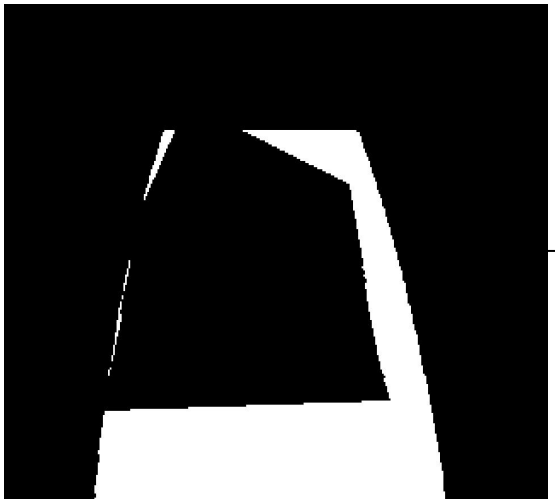
$G = F \otimes I$



2. Proposed Approach

2. Shifting

N



$$L_C = \frac{\text{ceil}(\frac{side(f_s)}{2})}{f_s} \times \alpha$$

$L = L_C \times N$

2. Proposed Approach

3. Final Confidence Map

I $L = L_C \times N$ M

2. Proposed Approach

c. Combination of several cameras, each with one or two algorithms

1. IPM (Inverse Perspective Mapping) technique to transform the polygons into the same frame;
2. Combination of the warped polygons through the logic operations “AND” and “XOR”;
3. Confidence maps of each camera are weighted summed.

3. Experimental Infrastructure

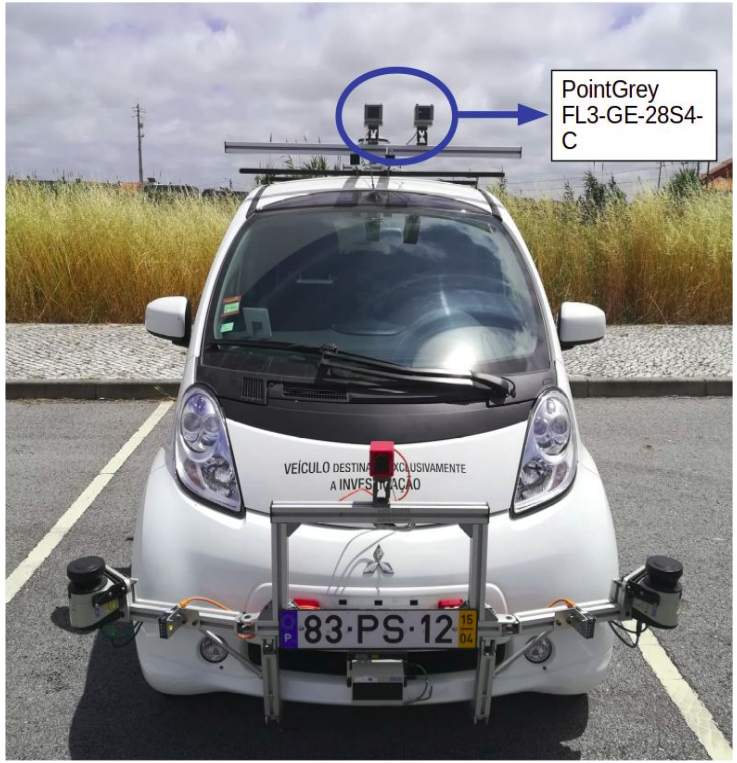
a. Hardware

2 Cameras

Point Grey FL3-GE-28S4-C:

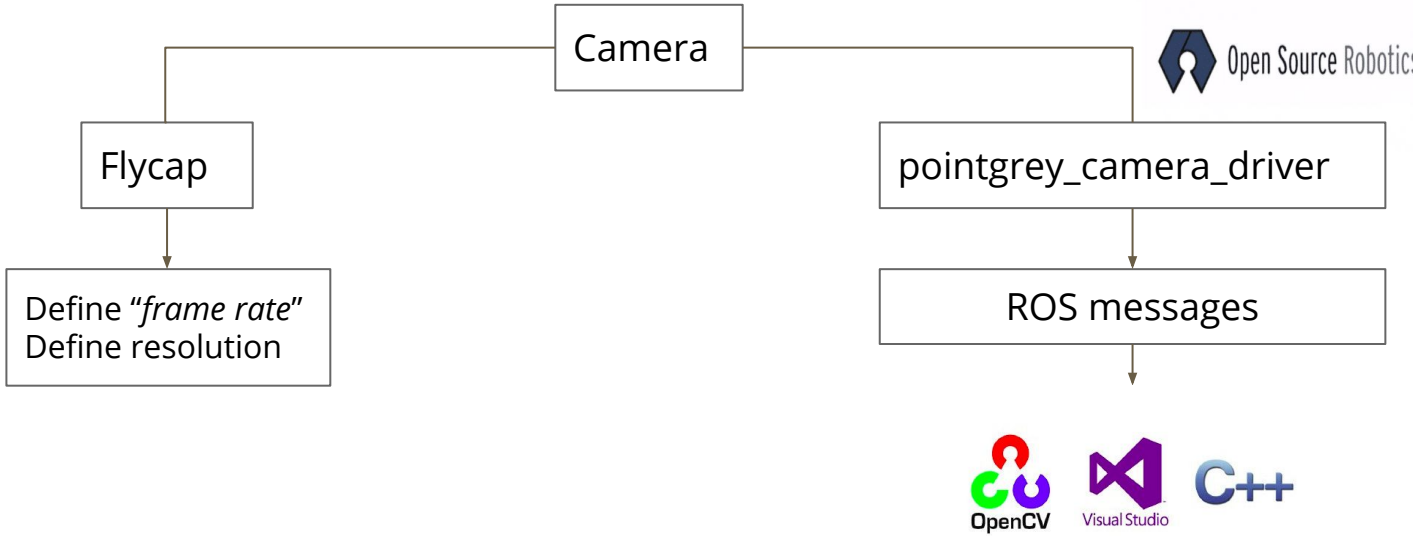
- Resolution: 964 ×724
- FPS: 15

Fixation and protection cameras system



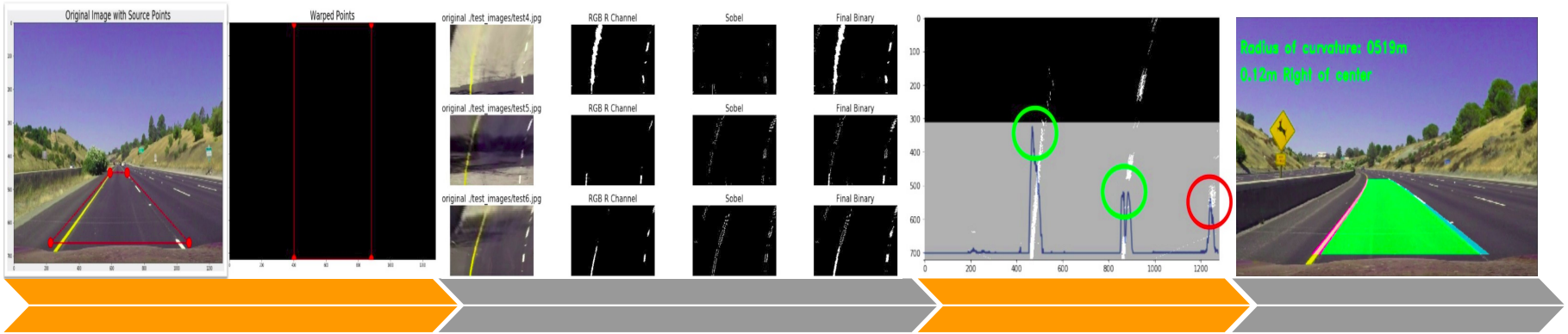
3. Experimental Infrastructure

b. Software



3. Experimental Infrastructure

b. Software - Processor Algorithm based on Classical Techniques



Warp Transformation

Transformation of the image perspective (similar technique to IPM).

Lines Segmentation

Combination of two techniques: “Colour Selection” e “Edge Detection”.

Curve Fitting

2nd degree polynomial approximation in order to obtain the curve.

Final Image

Final representation of the road lane line.

3. Experimental Infrastructure

b. Software - Processor Algorithm based on Deep Learning Techniques

- Semantic Segmentation;
- CamVid dataset;
- 11 Classes;
- Encoder-Decoder.

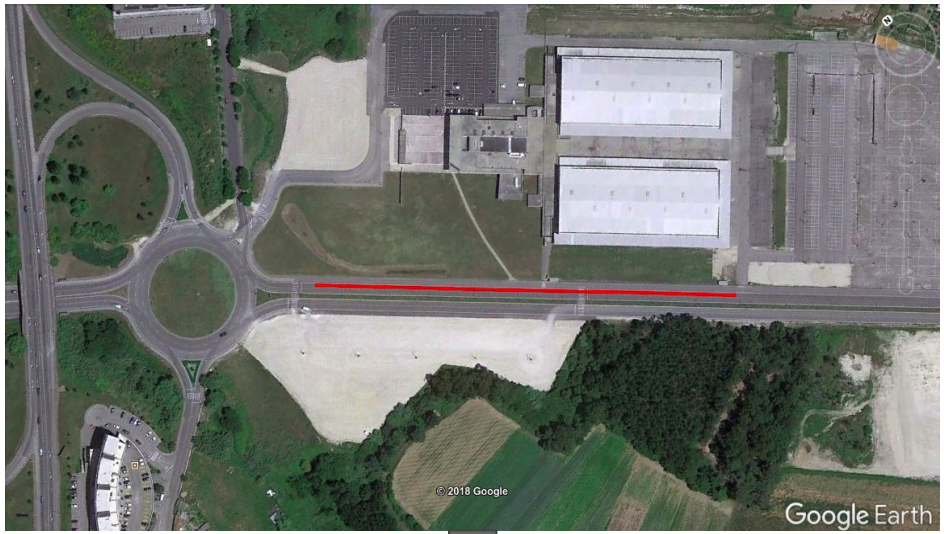
4. Experiments and Results

Validate/comprove:

- Utility;
- Scalability;
- Reliability.

Experiments:

1. 1 single camera + 2 algorithms
2. 2 cameras + 2 algorithms



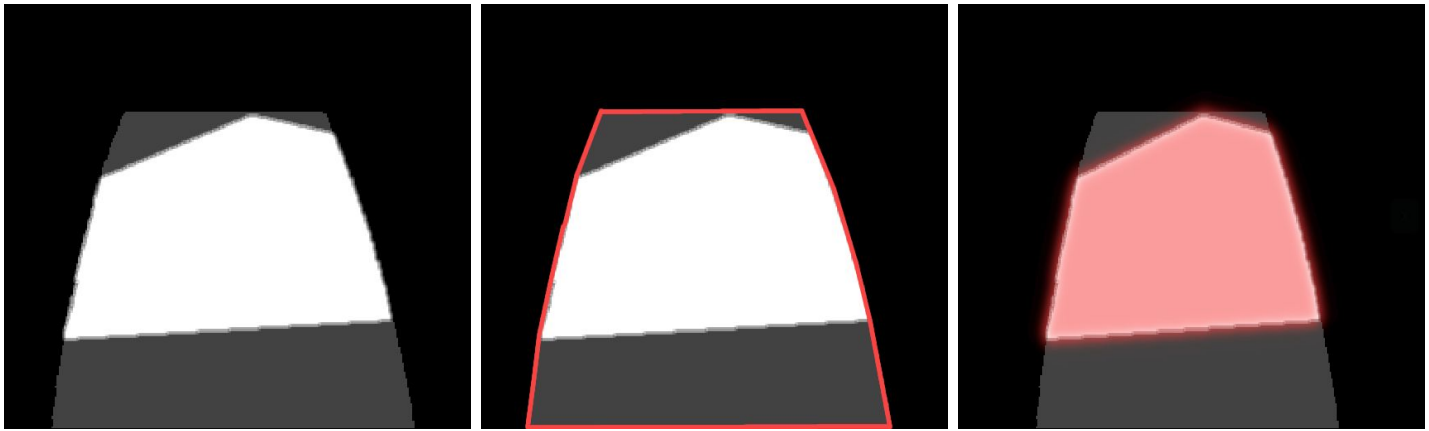
360 assessed frames

4. Experiments and Results

Indices:

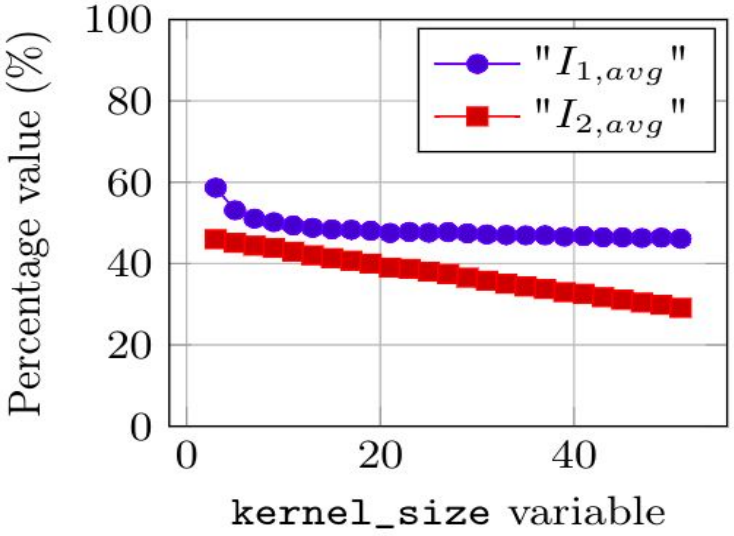
$$I_1 = \frac{WCA}{A_T}$$

$$I_2 = \frac{A_C}{A_T}$$

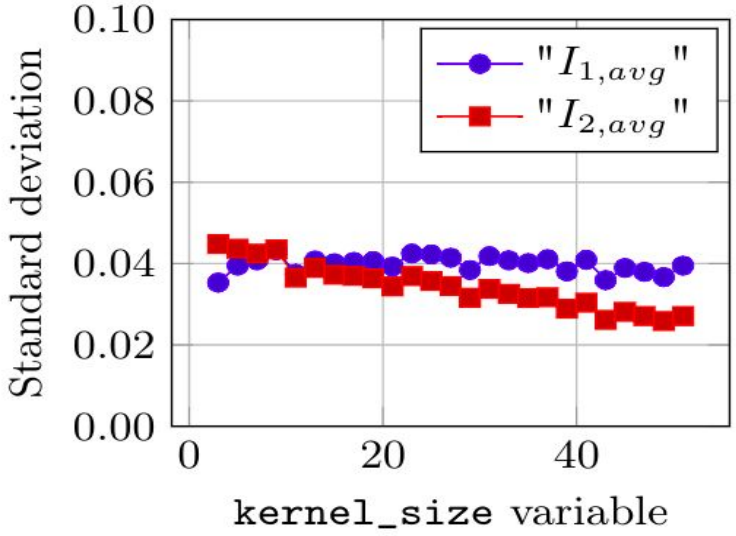


4. Experiments and Results

1 single camera + 2 algorithms



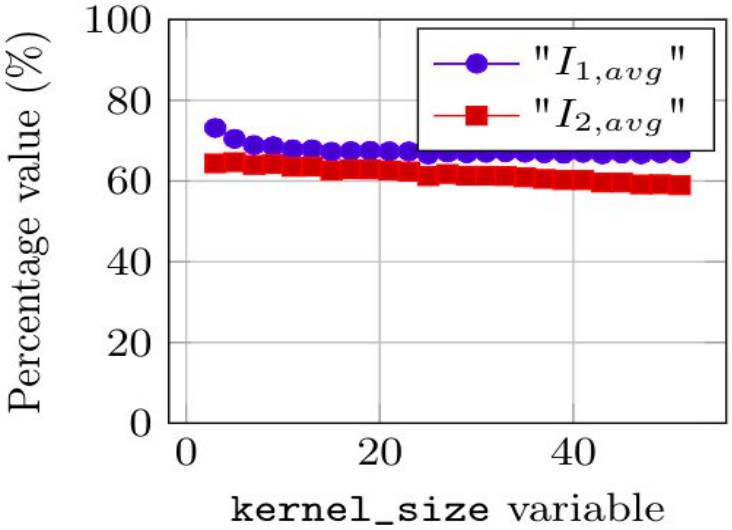
(a) Variation of the indices (%).



(b) Standard deviation values.

4. Experiments and Results

2 cameras + 2 algorithms



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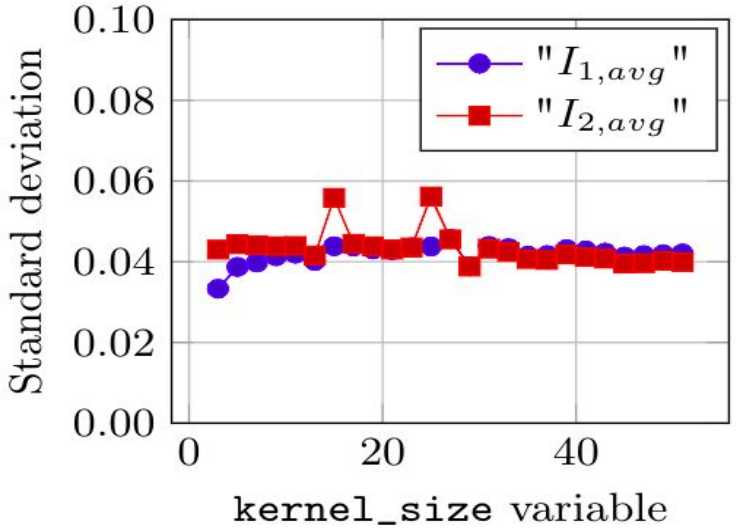

(b) Standard deviation values.

5. Conclusions

- More robust detect road maps than by using the algorithms individually;
- Two types of output representations are converted into an unique representation to allow the merging procedures;
- Valid approach to merge traditional computer vision techniques and DL based classifiers;
- Valid approach to combine multiple source road detection algorithms;
- Next step: migrate into a unified representation, probably based in occupancy grids, to merge data from different sources (LIDAR and cameras).

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